(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 721 761 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.07.1996 Bulletin 1996/29

(51) Int. Cl.[6]: **A47L 15/42**

(21) Application number: **95120638.2**

(22) Date of filing: **28.12.1995**

(84) Designated Contracting States:
DE ES FR GB IT SE

(30) Priority: **12.01.1995 IT PN950005**

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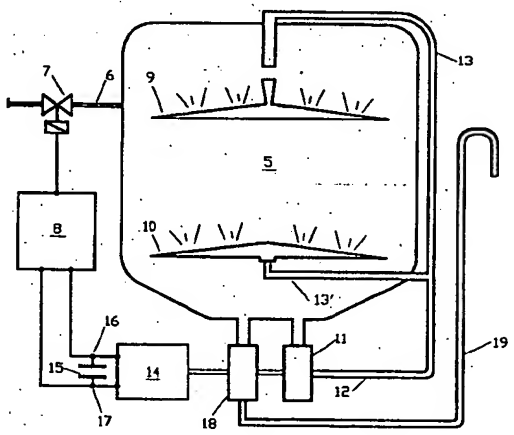
(54) Washing machine with dynamic water inlet control arrangement

(57) Dishwashing machine comprising a valve (7) which is open during a water inlet phase, and a circulation pump (11) which is energized during the water inlet phase. A control arrangement is driven by a signal (V) which is proportional to the outlet pressure of the circulation pump so as to close the inlet valve (7) when signal variations decrease below a pre-determined value. The circulation pump (11) is driven by a single-phase asynchronous motor (14) with a phase-shift capacitor (15) from which the signal (V) is derived. A further signal (U) can be derived from said capacitor (15) to drive the control arrangement so as to determine the correct de-energization of a discharge pump (18).



-Fig. 1-

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Description

The present invention refers to a washing machine, such as clothes washing or dishwashing machine, of the type in which water being filled into a wash vessel is circulated in a closed circuit by a circulation pump and is finally let out by means of a discharge pump. In particular, the present invention refers to a washing machine provided with a control arrangement which is adapted to precisely determine the amount of water which is let into the wash vessel.

A dynamic control arrangement is known, for instance from the disclosure in EP-A-0 118 719, which is adapted to control the operation of a water inlet valve of a dishwashing machine, the circulation pump of which is operating during the water inlet phase to be controlled. A specially provided transducer means delivers a control signal which is proportional to the delivery pressure of the pump and which substantially comprises a direct-current component and damped oscillating component. When the amplitude of the variations of the control signal decreases below a predetermined value, the water inlet valve is shut off.

Such a control arrangement may operate on the basis of any physical quantity which is representative of the delivery pressure of the water circulating pump. For instance, such a quantity may be correlated to the flow rate or the rotating speed of the pump, or to the active power input of the driving motor of the pump; in particular, it may be the phase shift between the voltage and the current of said motor.

In principle, this state-of-art control arrangement enables water fill phases to be carried out which are optimally and very accurately controlled regardless of the variables that may be introduced by the water supply system, such as for instance the delivery pressure of the water supply mains.

On the other hand, such a control arrangement calls for the utilization of relatively expensive electronic components. In particular, it requires the use of a transducer of a particularly sophisticated type, which may ultimately prove scarcely reliable.

Furthermore, the need arises for the application of special means adapted to appropriately amplify the control signal in order to provide an adequate definition of the same signal.

It would therefore be desirable, and it is actually a purpose of the present invention, to provide a washing machine comprising a dynamic water inlet control arrangement, which is particularly accurate in its operation, although making use of only a small number of substantially simple, reliable and unexpensive component parts.

It is a further purpose of the present invention to provide a washing machine of the above cited kind, in which the dynamic water inlet control arrangement is capable of controlling also the operation of the discharge pump in a simple, but particularly effective manner.

According to the present invention, such aims are reached in a washing machine with a dynamic water inlet control arrangement having the characteristics and features as recited in the appended claims.

The characteristics and the advantages of the present invention will anyway be more clearly understood from the description which is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a basic schematical view of a washing machine according to the present invention;
- Figures 2 and 3 are views of the electric schematics of the control arrangement of the washing machine according to respective embodiments of the present invention;
- Figures 4 and 6 are diagrammatical views showing, in a simplified form, respective signals processed in the control arrangement of the washing machine.

With particular reference to Figure 1, the washing machine considered here might well be a clothes washing machine, but it is preferably a household-type dishwashing machine comprising mainly a wash vessel 5 which can be supplied with mains water through a conduit 6 provided with an electromagnetic valve 7, or the like, controlled by the programme sequence control unit 8 of the washing machine.

In a per sè known manner, the wash vessel 5 houses an upper rotating spray arm 9 and a lower rotating spray arm 10 which are adapted to be supplied by a circulation pump 11 with the water that the latter takes in from the bottom of the wash vessel 5. In particular, the rotating spray arms 9 and 10 are connected with the delivery (or outlet) 12 of the circulation pump 11 through appropriate conduits 13, 13'.

The circulation pump 11 is driven by an electric motor 14 which is controlled by the programme sequence control unit 8 of the machine.

According to a feature of the present invention, the motor 14 is a single-phase asynchronous motor of the type adapted to be started to rotate by means of phase-shifting capacitive means 15.

As it will be described in a more detailed manner further on, the opposite terminals 16, 17 of the capacitor 15 are preferably connected to corresponding driving inputs of the programme sequence control unit 8.

In a per sè known manner, the dishwashing machine comprises also a discharge pump 18 which, as duly controlled by the programme sequence control unit 8 of the machine, is adapted to deliver to an outlet pipe 19 the water that had previously been filled into the wash vessel 5 of the machine.

In a preferred manner, also the discharge pump 18 is arranged so as to be driven by said asynchronous driving motor 14, which can to this purpose be of the reversing type, such as described for instance in EP-A-0 268

835. In particular, the circulation pump 11 and the discharge pump 18 are capable of being driven selectively when the driving shaft of the motor 14 rotates in a first or in a second direction, respectively. In other words, when the motor 14 is driven to rotate in a direction, only the circulation pump 11 will be operating. On the contrary, when the motor 14 is caused to rotate in the opposite direction, only the discharge pump 18 will be driven.

With reference also to Figure 2, it can be noticed that the asynchronous motor 14 comprises a pair of stator windings 20, 21, an end of which is connected to an energization terminal 22. The opposite end of the winding 20 is connected to a second energization terminal 23 (which in a preferred manner is connected to ground), as well as to the terminal 16 of the capacitor 15.

The opposite end of the winding 21 is on the contrary connected to the opposite terminal 17 of the phase-shift capacitor 15. A substantially sine-wave supply voltage, such as for instance a 220-VAC voltage, is applied across the energization terminals 22 and 23. The terminal 17 of the phase-shift capacitor 15 is connected, via an AC/DC converter 24, to a driving input 25 of a microprocessor 26. This microprocessor, together with the converter 24, forms a dynamic control arrangement which is part of the programme sequence control unit 8 of the machine and comprises an output 27 that in a per sè known manner is adapted to drive the electromagnetic or similar valve 7.

Referring now also to Figure 4, the description will follow, by mere way of example, of the manner in which the phase provided to fill water into the wash vessel 5 of the dishwashing machine may take place.

At an instant t_0, the programme sequence control unit 8 of the machine causes the electromagnetic valve 7 to open and, at an instant t_1, it then causes the motor 14 to be energized. The motor 14 therefore starts to rotate, thereby driving the circulation pump 11 accordingly, in a direction of rotation which is determined by the phase-shift capacitor 15, across the terminals of which a voltage signal V develops. As it could be found also experimentally, said voltage signal V is substantially proportional to the water outlet or delivery pressure of the circulation pump 11. To state it more precisely, the voltage signal V is substantially inversely proportional to the water outlet pressure of the circulation pump 11. As a result, the voltage signal V tends to decrease with the time, until, at an instant t_2 in which the circulation pump 11 starts to prime, a damped oscillation starts to appear in the voltage signal V, said damped oscillation being actually representative, in a substantially per sè known manner, of the operational conditions of the pump 11.

Through the converter 24, the voltage signal V drives the microprocessor 26 which in a per sè known manner thereby causes the electromagnetic valve 7 to close when, at an instant t_3, the variations of the signal V decrease to a level below a pre-determined value. In other words, when the component parts involved are appropriately sized, the electromagnetic valve 7 is caused to close as soon as the smallest amount of water has been filled into the wash vessel 5 of the dishwashing machine as required to enable the circulation pump 11 to prime in an optimum manner.

As already stressed above, this is an inherently known consideration. However, according to the present invention the instant t_3 is determined without any need arising for special transducer means to be employed in view of delivering a control signal which is proportional to the outlet or delivery pressure of the pump 11. As a matter of fact, the control signal V is directly derived (with respect to ground) at the terminal 17 of the phase-shift capacitor 15 which therefore, according to the present invention, performs a double duty in that it starts the rotation of the motor 14 and supplies an appropriate control signal to the microprocessor 26.

In addition, in a quite advantageous manner the dynamic control arrangement of the washing machine according to the present invention does not require any amplifier for the control signal V, which is available across the terminals of the capacitor 15 in an already amplified form, for instance with a value of approx. 700 V. This owing particularly to the fact that, by applying a substantially sine-wave supply voltage (220 V) to the terminals 22, 23, the impedances represented by the winding 21 and the capacitor 15 of the motor 14 are crossed by a same current I. Correspondingly, across the terminals of the impedances 21 and 15 (an inductive impedance and a capacitive one, respectively) respective voltage drops form which are vectorially opposite with respect to each other and the module of which is directly proportional to the value of the respective impedances. Since in a normal single-phase asynchronous motor 14 the capacitive impedance 15 is substantially greater than the inductive impedance 21, the absolute value of the voltage V derived at the terminals of the capacitor 15 is practically substantially amplified, as this has already been explained above.

According to the present invention, therefore, the capacitor 15 also performs a further duty in that it amplifies the control signal V which, as a result, has an advantageously high definition and allows for an accurate driving of the dynamic control arrangement 24, 26.

Through simple modifications, which will be explained in greater detail with reference to Figure 3, the washing machine according to the present invention can further be enabled to effectively control also the water outlet phases in which the water is let out of the wash vessel 5, particularly in the preferred case in which the circulation pump 11 and the discharge pump 18 are both driven by the same asynchronous motor 14, such as previously described.

The motor 14 is of the reversing type, through the action of a change-over switch or reversing switch 28 controlled via a relay 29 or the like, which is driven by a further output 30 of the microprocessor 26. The latter has also a further input 31 which is connected, via an AC/DC converter 32, to the terminal 16 of the phase-shift capacitor 15. In particular, the change-over switch 28 has a "disconnected" resting position shown in Figure 3 and can be selectively switched over to a first and a second

operational or active position in which it energizes the motor 14 via the terminal 16 and the terminal 17, respectively, of the phase-shift capacitor 15.

When the change-over switch 28 is connected to the terminal 16, the motor 14 is operated to rotate in a first direction of rotation, in which only the circulation pump 11 is operating. In this particular condition, the control signal V derived at the terminal 17 of the capacitor 15 drives the input 25 of the microprocessor 26 in the afore described manner.

When the change-over switch 28 is connected to the terminal 17, the motor 14 is operated to rotate in the opposite direction of rotation, in which only the water discharge pump 18 is operating. In this particular condition, the input 31 of the microprocessor 26 is driven, via the converter 32, by a further voltage signal derived at the terminal 16 of the phase-shift capacitor 15.

As it has been found also experimentally, such a further voltage signal (indicated at U in Figure 5) is inversely proportional to the water outlet pressure of the discharge pump 18. In particular, it has been ascertained that the voltage U reaches a given value V_0 at the end of each water outlet phase, ie. when the discharge pump 18 starts to substantially unprime, thereby representing a reduced dynamic load for the driving motor 14. As a result, the microprocessor 26 can be easily set by anyone skilled in the art so as to switch the change-over switch 28 in its resting position when the input 31 thereof detects that the above cited value C_0 has been attained. To state it more precisely, with reference to Figure 5, at an instant t_1 the programme sequence control unit 8 operates the discharge pump 18 by switching the change-over switch 28 into contact with the terminal 17 of the capacitor 15. The discharge pump is initially in an optimum priming condition and starts then to unprime in correspondence of an instant t_2 at which the voltage U at the terminal 16 reaches the above cited value V_0. At said instant t_2, therefore, the microprocessor 26 energizes the relay 29 so as to switch the change-over switch 28 in its resting position. As a result, the discharge pump 18 stops operating.

It should be noticed that, in the traditional solutions, the water outlet phase has a fixed, pre-determined duration, at the end of which the discharge pump, in view of ensuring an adequate water outlet, keeps practically operating in a substantially unprimed state. It will be readily appreciated that this practically means that energy is thereby used to no avail and noise is undesirably generated in the washing machine.

On the contrary, according to the present invention the discharge pump 18 is operated in an efficient manner, whereby all of the main variables of the water flow and discharge system are duly kept into account. In particular, the operation of the discharge pump 18 is cut off as soon as the water contained in the vessel 5 is detected to have been substantially discharged, thereby avoiding a substantial, undesired generation of noise.

Conclusively, it can be readily appreciated that the washing machine according to the present invention makes use of simple and realiable means to optimally control both the water inlet and the water outlet phases.

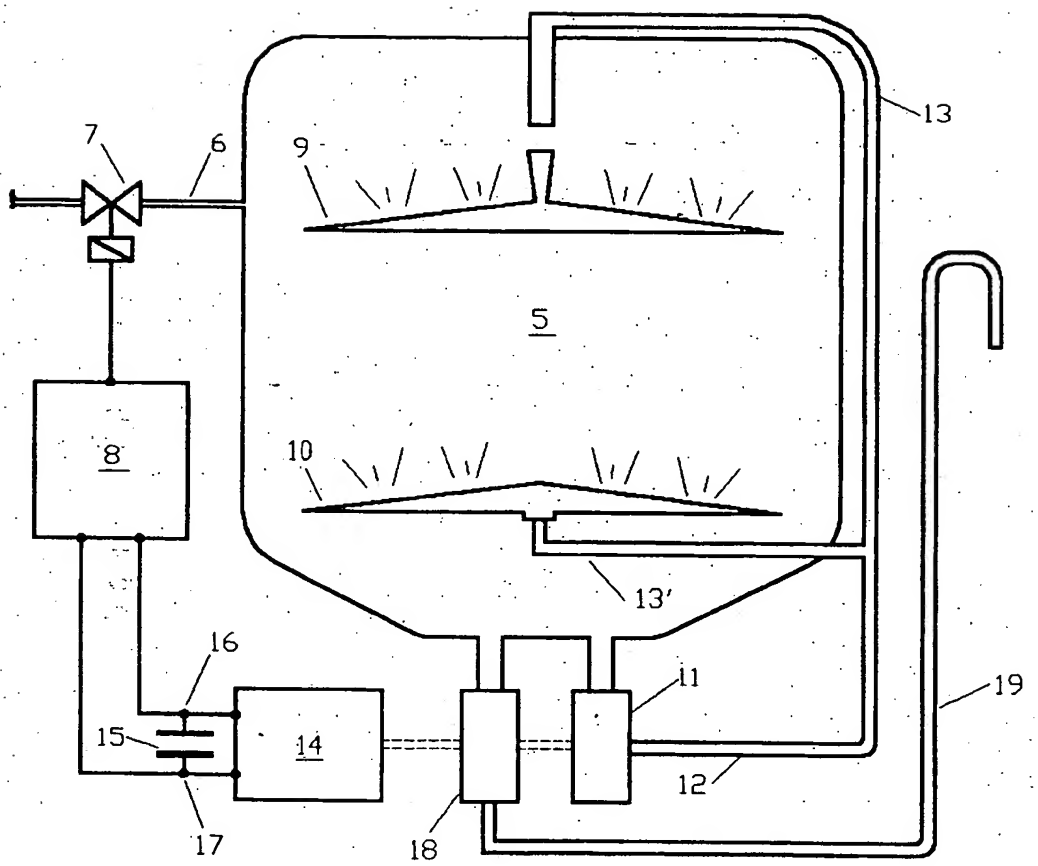
It will be further appreciated that the above described washing machine may undergo a number of modifications without departing from the scope of the present invention.

Claims

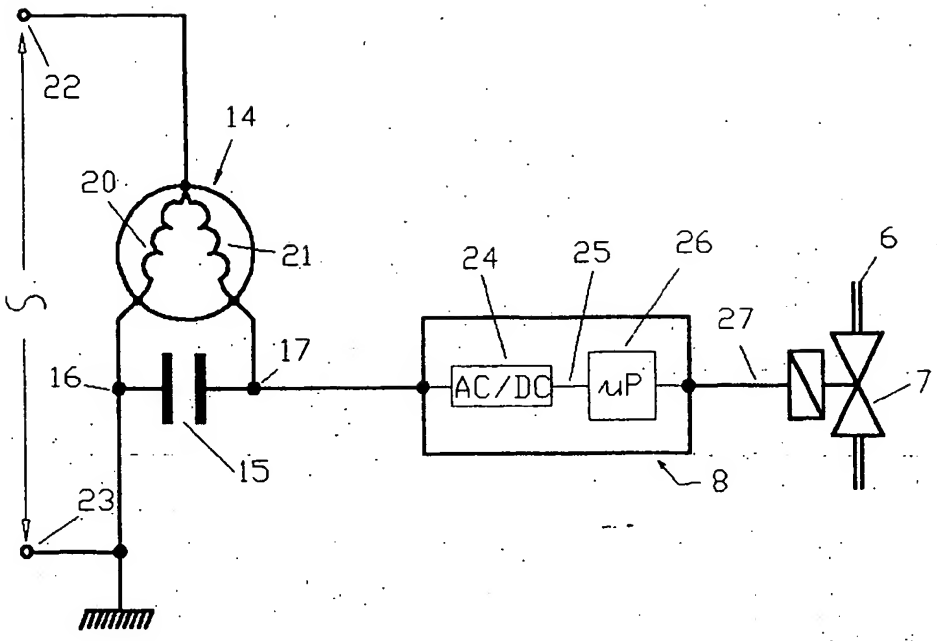
1. Washing machine provided with a dynamic water inlet control arrangement, comprising a water-inlet valve which is actuated to open during at least a water inlet phase, and a water circulation pump which is driven by an electric motor during at least the last portion of the water inlet phase, said control arrangement being driven by a signal which is proportional to the outlet pressure of the circulation pump so as to close the inlet valve when signal variations decrease below a pre-determined value, **characterized in that** said driving motor (14) is an asynchronous motor adapted to be started into rotation by means of capacitive phase-shift means (15), at a first terminal (17) of which a voltage (V) is derived which constitutes said signal driving the control arrangement (24, 26).

2. Washing machine according to claim 1, **characterized in that** said asynchronous motor (14) is a single-phase motor.

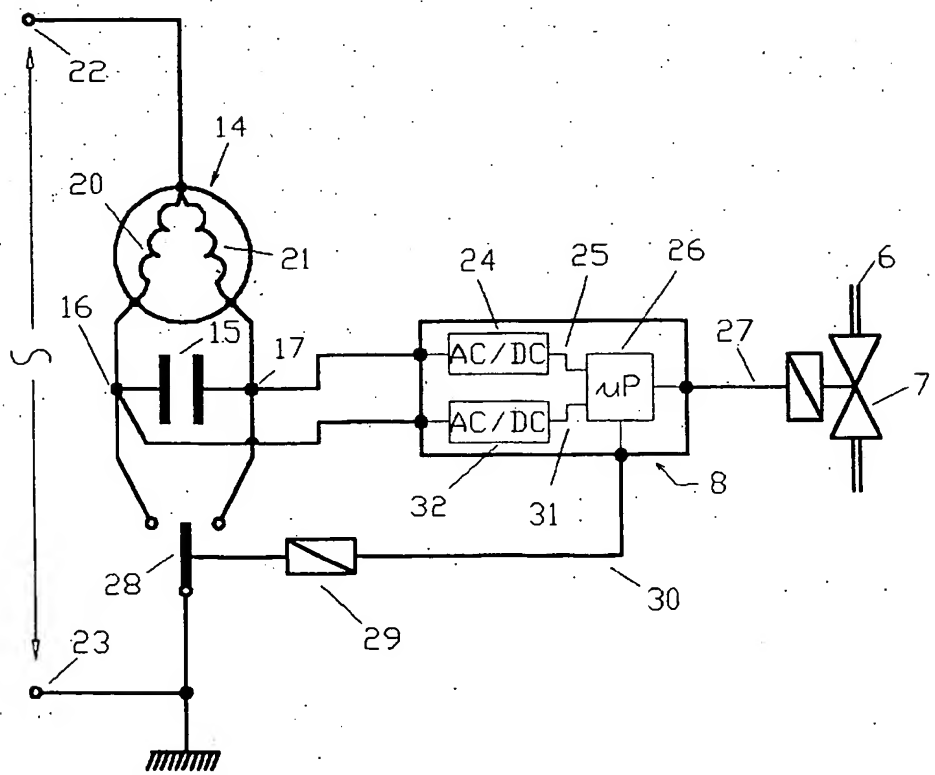
3. Washing machine according to claim 1, wherein the asynchronous motor is provided to rotatably drive also a discharge pump for letting out the water previously filled into the machine, and it is further adapted to be selectively operated to run in a first and a second direction of rotation in which only the circulation pump and only the discharge pump is operating, respectively, **characterized in that** said selective operation of the asynchronous motor (14) is carried out through at least a controlled change-over switch (28) adapted to selectively provide connection to said first terminal (17) and a second terminal (16) of the capacitive phase-shift means (15), a further signal (U) being derived at said second terminal (16) which is proportional to the outlet pressure of the discharge pump (18), the control arrangement (32, 26) being adapted to be driven by said further signal and de-energize the discharge pump (18) when said further signal reaches a given value (V_0), in correspondence of which the water is substantially discharged from the machine.



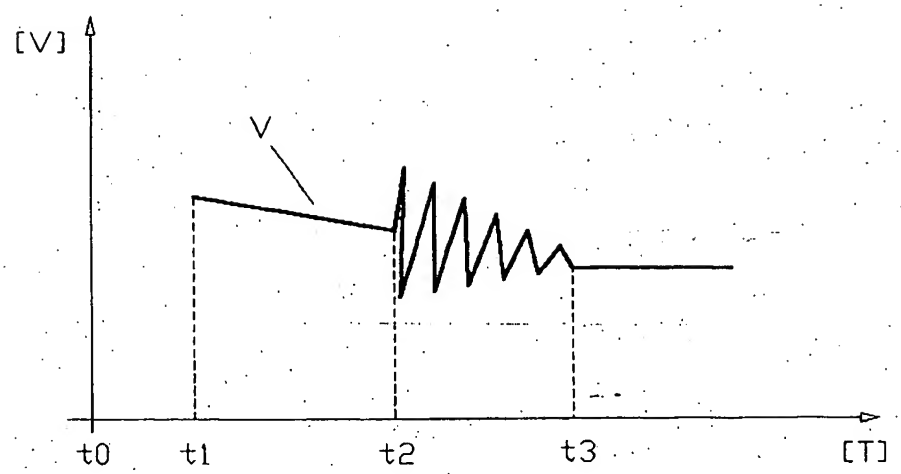
-fig. 1-



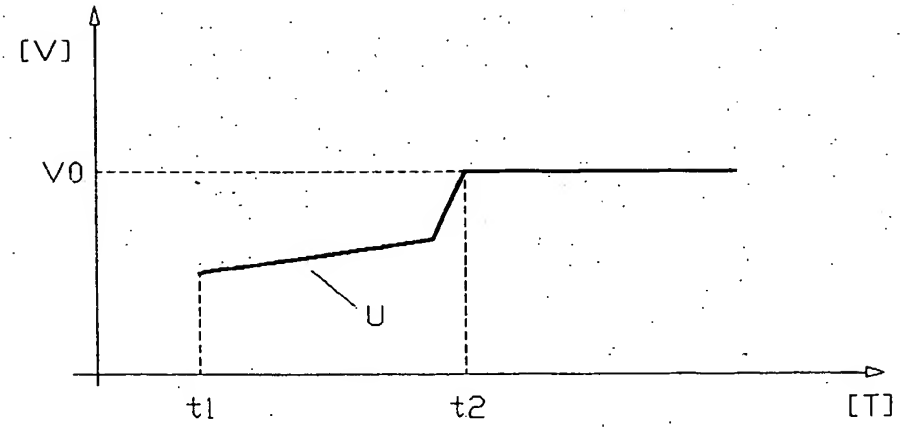
-fig. 2-



-fig. 3-



-fig. 4-



-fig. 5-

(19) Europäisches Patentamt
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(11) EP 0 721 761 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
20.11.1996 Bulletin 1996/47

(51) Int. Cl.[6]: **A47L 15/42**

(43) Date of publication A2:
17.07.1996 Bulletin 1996/29

(21) Application number: **95120638.2**

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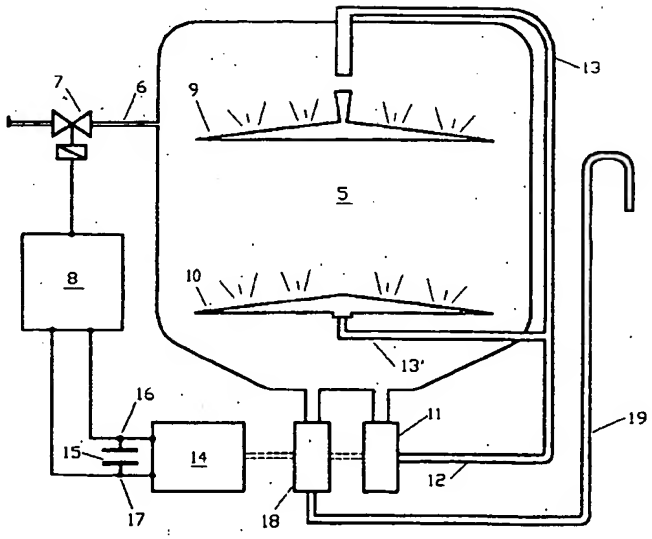

-Fig. 1-

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EUROPEAN SEARCH REPORT

Application Number
EP 95 12 0638

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	FR-A-2 577 788 (ESSWEIN SA) 29 August 1986 * page 4, line 18 - page 5, line 26; claims 1-5,11; figures 1-3 *	1,2 3	A47L15/42
X	US-A-4 481 786 (BASHARK LARRY T) 13 November 1984 * column 1, line 7-17 * * column 2, line 63-68 * * column 7, line 25 - column 8, line 24 * * column 26, line 23 - column 27, line 30 * * column 30, line 19-42 *	1,3	
A	EP-A-0 326 893 (HANNING ELEKTRO WERKE) 9 August 1989 * column 2, line 31-55; claim 1 *	1	
A,P	US-A-5 409 023 (SANTAROSSA GIANNI ET AL) 25 April 1995 * column 3, line 23-30 - column 4, line 1-55 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

A47L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	10 September 1996	Laue, F

CATEGORY OF CITED DOCUMENTS

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